
British Standard

Sound system equipment

Part 6. Methods for specifying and measuring the characteristics of auxiliary passive elements

[IEC title : Sound system equipment. Part 6 : Auxiliary passive elements]

Equipements pour systèmes électroacoustiques

Partie 6. Méthodes de spécification et de mesure des caractéristiques des éléments auxiliaires passifs

Elektroakustische Geräte

Teil 6. Verfahren zur Festlegung und Messung der Kennwerte von passiven Hilfsgliedern

National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Committee and is identical with Publication 268.6 : 1973 'Sound system equipment' Part 6 'Auxiliary passive elements' published by the International Electrotechnical Commission (IEC). The text of this Part of BS 6840 is unchanged from the text of BS 5428 : Part 4 : 1978 which is now withdrawn.

All Parts and Sections of BS 5428 will be published as Parts of BS 6840 in order to achieve consistency of numbering between the corresponding Parts of the IEC Publication and the British Standard.

BS 6840 consists of the following parts:

- Part 1 Methods for specifying and measuring general characteristics used for equipment performance (Supersedes part of BS 5428 : Part 1)
- *Part 2 Specification for general terms and calculation methods (Supersedes part of BS 5428 : Part 1)
- *Part 3 Methods for specifying and measuring the characteristics of sound system amplifiers (Supersedes BS 5428 : Part 2)
- Part 4 Methods for specifying and measuring the characteristics of microphones (Previously BS 5428 : Part 3)
- *Part 5 Methods for specifying and measuring the characteristics of loudspeakers (Supersedes BS 5428 : Part 11 and Part 11 : Supplement 1)
- Part 6 Methods for specifying and measuring the characteristics of auxiliary passive elements (Previously BS 5428 : Part 4)
- *Part 7 Methods for specifying and measuring the characteristics of headphones and headsets (New)
- Part 8 Methods for specifying and measuring the characteristics of automatic gain control devices (Previously BS 5428 : Part 7)
- Part 9 Methods for specifying and measuring the characteristics of artificial reverberation, time delay and frequency shift equipment (Previously BS 5428 : Part 8)
- Part 10 Specification for programme level meters (Supersedes BS 5428 : Part 9)
- *Part 11 Specification for application of connectors for the interconnection of sound system components (Supersedes BS 5428 : Part 5 : Section 5.2)
- *Part 12 Specification for application of connectors for broadcast and similar use (Supersedes BS 5428 : Part 5 : Section 5.3)
- Part 13 Guide for listening tests on loudspeakers (New)
- Part 14 Guide for circular and elliptical loudspeakers: outer frame diameters and mounting dimensions (Previously BS 5428 : Part 5 : Section 5.1)
- *Part 15 Specification for matching values for the interconnection of sound system components (Supersedes BS 5428 : Part 10)
- *Part 16 Guide to the RASTI method for the objective rating of speech intelligibility in auditoria (New)

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever the word 'Publication' or 'Recommendation' appears, referring to this standard, it should be read as 'British Standard'.

References to page numbers in the text relate to the IEC page numbers given in brackets at the bottom of each page.

Cross-references

International standard	Corresponding British Standard
IEC 68	BS 2011 Basic environmental testing procedures (Most separately published Parts are identical)
IEC 94	BS 6288 Magnetic tape sound recording and reproducing systems (Separately published Parts are identical)
IEC 98	BS 4852 Methods of defining and measuring the characteristics of disk record playing equipment
IEC 268-1 : 1985	BS 6840 Sound system equipment Part 1 : 1987 Methods for specifying and measuring general characteristics used for equipment performance (Identical)

*In preparation.

IEC 268-2 : 1971	BS 5428 Methods for specifying and measuring the characteristics of sound system equipment *Part 1 : 1977 General (Technically equivalent)
IEC 268-3 : 1969	*Part 2 : 1979 Amplifiers (Technically equivalent)
IEC 617 : 1983†	BS 3939 Guide for graphical symbols for electrical power, telecommunications and electronics diagrams (Separately published Parts are identical)

The Technical Committee has reviewed the provisions of IEC 27, to which reference is made in 6.2 and IEC 65, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this British Standard. A related British Standard to IEC 27 is the series of Parts of BS 5775 which are themselves identical to the ISO 31 series of Parts.

A related British Standard to IEC 65 : 1976 is BS 415 : 1979.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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*These Parts of BS 5428 will be withdrawn when revision of IEC 268-2 and IEC 268-3 are published and implemented as Parts of BS 6840.

†IEC 617 : 1983 supersedes IEC 117.

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British Standard

Sound system equipment

Part 6. Methods for specifying and measuring the characteristics of auxiliary passive elements

1. Scope

Auxiliary passive elements shall be understood to include such elements as attenuators, transformers, filters and equalizers, applied as separate units to be combined with other separate sound system units to constitute a complete sound system.

Notes 1. — Auxiliary passive elements which are intended to be mounted as components in a sound system unit and to form a non-interchangeable part of such a unit, are not within the scope of this Recommendation.

Some characteristics are to be specified for all types of auxiliary passive elements. These are given in Chapter I and Section One. Further characteristics to be specified for the different types of auxiliary passive elements are given in Section Two, Clauses 17, 18 and 19.

2. — Auxiliary elements may sometimes include electronic amplification, in which case these elements are considered as amplifiers and are dealt with in IEC Publication 268-3, Sound System Equipment, Part 3: Sound System Amplifiers.
3. — If a network has more than four terminals as e.g. a cross-over network, it is nevertheless treated in this Recommendation as an assembly of four terminal networks.

2. Object

This Publication gives recommendations relative to the characteristics to be specified and the relevant measuring methods for auxiliary passive elements for sound system equipment.

In general, the methods of measurement recommended are those which are seen to be the most directly related to the definitions. This does not exclude the use of other methods which will give equivalent results.

CHAPTER 1: CONDITIONS FOR SPECIFICATION AND MEASUREMENT

3. General conditions

Reference is made to IEC Publication 268-1, Sound System Equipment, Part 1: General, as concerns:

- units and system of measurement;
- frequencies of measurement;
- quantities to be specified and their accuracy;
- marking;
- ambient conditions;
- filters, networks, and measuring instruments for noise specification and measurement;
- individual specification and type specification;
- graphical presentation of data;
- scales for graphical presentation of data.

4. **Rated conditions and normal working conditions**

4.1 *Introduction*

For convenience in specifying how auxiliary passive elements are to be set up for measurement or verification, certain sets of conditions have been defined in this Recommendation under the respective titles of rated conditions and normal working conditions.

Three ratings are basic to the formulation of these concepts:

- rated source impedance;
- rated source e.m.f.;
- rated load impedance.

To obtain the correct conditions for measurements, the above-mentioned ratings shall be taken from the manufacturers' specification. These ratings themselves are not subject to measurement but they constitute the basis for measuring the other characteristics.

The prefix "rated" applied to other characteristics relates to the specification or measurement of the particular characteristic under rated conditions or under conditions unambiguously connected with them. This applies to the following characteristics:

- rated matched insertion loss;
- rated equivalent source e.m.f. for external magnetic field of power supply frequency.

Concerning the position of the controls for rated conditions and normal working conditions, it must be taken into account that, when an auxiliary passive element is provided with a volume (attenuation) control and/or a tone control, the primary use of the element (variable attenuator, variable filter or equalizer) is generally to give a means of adjusting volume and frequency response in a sound system. Hence, all settings of the controls can be important.

Some characteristics may be measured only for one specified setting of the controls, particularly when they are influenced only slightly by the position of the controls themselves. This particular position of the controls may be taken as "reference setting". In most cases, rated conditions and normal working conditions will include not only "reference setting" but also other settings of the controls, in order to supply more complete information.

The values of the same characteristics, for different settings, will be presented either in a table or a graph.

4.2 *Rated conditions*

An auxiliary passive element, considered as a four-terminal network with a specified pair of input terminals and a specified pair of output terminals, will be understood to be working under rated conditions when the following conditions have been fulfilled:

- source e.m.f. connected in series with the rated source impedance to the input terminals;
- output terminals terminated with the rated load impedance;
- terminals not used terminated as specified;
- source e.m.f. adjusted to a sinusoidal voltage equal to the rated source e.m.f. at that frequency at which the output signal is the least influenced by the tone controls, if any. In the absence of a clear reason to the contrary, this frequency shall be the standard reference frequency of 1 000 Hz (see IEC Publication 268-1);

- volume control attenuation, if any, set to a specified position to give a specified attenuation;
- tone controls, if any, set to a specified position to give the specified frequency response.

4.3 *Normal working conditions*

An auxiliary passive element, considered as a four terminal network with a specified pair of input terminals and a specified pair of output terminals, will be understood to be working under normal working conditions when the following conditions have been fulfilled:

- connections and impedances as for rated conditions;
- source e.m.f. adjusted to a sinusoidal voltage of 10 dB below the rated source e.m.f.;
- source adjusted to the frequency specified for rated conditions unless otherwise stated;
- setting of the controls as for rated conditions unless otherwise stated.

4.4 *Personal safety and prevention of spread of fire.*

The passive element shall be designed and marked as indicated in IEC Publication 65, Safety Requirements for Mains Operated Electronic and Related Equipment for Domestic and Similar General Use.

Compliance shall be checked by inspection.

CHAPTER II: CHARACTERISTICS TO BE SPECIFIED AND THE RELEVANT MEASURING METHODS

SECTION ONE — AUXILIARY PASSIVE ELEMENTS

5. **Diagram**

5.1 *Structure diagram (block schematic)*

Characteristic to be specified

The structure diagram (block schematic) shall give adequate information about:

- basic circuit (e.g. block diagram);
- the nature of the input and output terminals (e.g. balanced or not balanced, connection to earth);
- shields (e.g. way of earthing);
- controls;
- internal and external means, as pre-adjusters, adaptors (switching or soldering contacts) intended for changing the external characteristics (such as: source, load impedance, attenuation).

Verification shall be checked by inspection.

6. Terminals and controls

6.1 *Marking*

Recommendations for marking the terminals and controls are given in IEC Publication 268-1, Clause 6, with the addition of the following requirements:

- the marking shall be such that it must be possible to adjust the controls and to identify their positions with sufficient accuracy in connection with the characteristics given in the manual.
- The marking can be carried out in the following ways:
 - at the terminals and controls;
 - in a description with respect to their function;
 - in the directions given in the manual.

6.2 *Symbols for marking*

Marking should preferably be composed of letter symbols, signs, numbers and colours, which are internationally intelligible. The use of texts shall be avoided as far as possible.

Letter symbols for quantities and units shall be in accordance with IEC Publication 27, *Letter Symbols to be Used in Electrical Technology*.

Graphical symbols with IEC Publication 117, *Recommended Graphical Symbols*.

Instructional symbols with the Publication: *Informative Symbols on Equipment, Part 1: Equipment Symbols for General Use* (under consideration).

Letter symbols or graphical symbols for items not involved in these publications and all other kinds of marking shall be clearly identified in the manual.

7. Input characteristics

7.1 *Rated source impedance*

7.1.1 *Characteristic to be specified*

The internal impedance, as specified by the manufacturer, of the source supplying the signal to a specified pair of input terminals of the element.

Notes 1. — Unless otherwise specified, the rated source impedance shall be a constant pure resistance.

2. — The manufacturer may also give the range of source impedances which he considers tolerable in practice.

7.2 *Input impedance*

7.2.1 *Characteristic to be specified*

The internal impedance of the passive element measured between a specified pair of input terminals under normal working conditions. It is given as a function of frequency or expressed as the lower limit of the input impedance in the effective frequency range.

Note. — If the input impedance can be satisfactorily represented by the impedance of a simple network, this network may be specified instead of presenting the curve of input impedance versus frequency.

7.2.2 Measuring methods

7.2.2.1 Balanced input

a) Free from earth

If the input circuit of the passive element is balanced and free from connections to the earth (or chassis), the following procedure is recommended:

1. The passive element is brought under normal working conditions, using a source with one earthed terminal, as shown in Figure 1, page 64.
2. The output voltage U_2 is measured.
3. The input voltage U_1 is measured.
4. A known resistor, of value R approximately one tenth of the input impedance, is connected in series with the input terminals, as shown in Figure 2, page 64.
5. The source e.m.f. is readjusted to obtain the initial output voltage U_2 .
6. The voltage U_R appearing across the resistor R is measured.
7. The modulus of the input impedance is $\frac{U_1}{U_R} \cdot R$.

b) Connected to earth

If the input circuit has a centre tap connected to the earth or chassis, the following procedure is recommended:

1. The passive element is brought under normal working conditions, using a source free from earth (or chassis), as shown in Figure 3, page 65.
2. The output voltage U_2 is measured.
3. The input voltage U_1 is measured by means of a balanced voltmeter.
4. A known resistor of value R is connected in series with the input terminals, as shown in Figure 4, page 65.
5. The source e.m.f. is readjusted to obtain the initial output voltage U_2 .
6. The voltage U_R appearing across the resistor R is measured by means of a balanced voltmeter.
7. The modulus of the input impedance is $\frac{U_1}{U_R} \cdot R$.

7.2.2.2 Unbalanced input

1. The passive element is brought under normal working conditions.
2. A shielded transformer is inserted between the source e.m.f. and the passive element. The shields are connected as shown in Figure 5, page 66.
3. The voltage appearing at the secondary terminals of the transformer is adjusted to a value of 10 dB below the rated source voltage.
4. The output voltage U_2 is measured.
5. The input voltage U_1 is measured.
6. A known resistor of value R is connected in series between one of the secondary terminals of the transformer and ground, as shown in Figure 6, page 66.

7. The voltage appearing at the secondary terminals of the transformer is adjusted to obtain the initial output voltage U_2 .
8. The voltage U_R appearing across resistor R is measured.
9. The modulus of the input impedance is $\frac{U_1}{U_R} \cdot R$.

7.3 *Rated source e.m.f.*

7.3.1 *Characteristic to be specified*

That e.m.f., specified by the manufacturer, for which the distortion in the output signal does not exceed a specified amount and/or the temperature limited input voltage is not exceeded. The element shall be connected according to rated conditions.

8. **Output characteristics**

8.1 *Rated load impedance*

8.1.1 *Characteristic to be specified*

That impedance, as specified by the manufacturer, by which the element is to be terminated at a specified pair of output terminals for measuring purposes.

Notes 1. — Unless otherwise specified, the rated load impedance shall be a constant pure resistance.

2. — The manufacturer may also give a range of load impedances which he considers tolerable in practice.

8.2 *Output impedance*

8.2.1 *Characteristic to be specified*

The internal impedance of the element measured between a specified pair of output terminals under normal working conditions. It is given as a function of frequency or expressed as the upper limit of the output impedance in the effective frequency range.

Note. — If the output impedance can be satisfactorily represented by the impedance of a simple network, this network may be specified instead of presenting the curve of output impedance versus frequency.

8.2.2 *Method of measurement*

The output impedance of a passive element may be either a real quantity (e.g. in resistive attenuators) or, more generally, a complex quantity. If inductors or transformers with magnetic cores are used in the passive element, the output impedance may be different for different output voltages.

Whereas the modulus of the input impedance can be measured by a simple procedure, no such procedure exists for measuring the modulus of the output impedance, when this impedance is a complex quantity.

The complex output impedance can be computed from the voltages occurring under three different conditions of load. In order that the influence, if any, of the output voltage on the output impedance is negligible, rather close values must be chosen, in this procedure, for the three output voltages. Hence, very accurate measuring apparatus is required.

In those cases where the output impedance within the effective frequency range can be approximated to a pure resistance, a simple procedure may be followed to obtain approximate results which are sufficiently accurate for normal practice.

1. The passive element is brought under normal working conditions.
2. The output voltage is measured for a number of loads ranging from $0.8 R_2$ to $1.2 R_2$ and including the rated load impedance R_2 .
3. The results of these measurements are expressed in a graph presenting the inverse output voltage as a function of the inverse load impedance. The tangent to this curve for the condition of rated load is drawn and the intersection of this tangent with the ordinate is determined, thus obtaining the apparent no-load output voltage U'_2 .
4. The output impedance is computed from the apparent no-load output voltage U'_2 , the output voltage for rated load U_2 , and the rated load impedance R_2 , according to the expression:

$$|Z| = \frac{U'_2 - U_2}{U_2} \cdot R_2$$

Notes 1. — The error in the result obtained by this procedure is larger according to the extent of the inductive or capacitive component of the output impedance. This procedure, therefore, should not be used to measure the output impedance near or outside the limits of the effective frequency range.

2. — If the passive network does not include inductors or transformers with magnetic cores, nor other non-linear elements, the output voltage measured under no-load conditions is equal to the value U'_2 obtained according to the above procedure. In this case only, U'_2 may be obtained in a simpler way by measuring the output voltage under no-load conditions.

9. Limiting characteristics

9.1 Overload source e.m.f.

9.1.1 Characteristic to be specified

The maximum source e.m.f. at the specified frequency, for which the passive element, connected for rated conditions and with an appropriate setting of the volume control (attenuation), can deliver the rated output voltage without exceeding the amplitude non-linearity specified for rated conditions.

The position of the tone controls, if any, shall be specified.

9.1.2 Method of measurement

The measuring procedure only refers to auxiliary passive elements which have volume (attenuation) and/or tone controls. When this is not the case, the overload source e.m.f. is equal to the rated value.

1. Volume and tone controls are set as specified for rated conditions.
2. The measurement is made by adjusting the value E_s of the source e.m.f. to obtain the amount of total harmonic distortion specified for this test.
3. The output voltage U_2 is measured.
4. The volume control (attenuation) is adjusted to successive positions of higher attenuation, increasing the source e.m.f. to restore the initial output voltage U_2 , until the total harmonic distortion of the output reaches the value specified for this test.

5. The maximum source e.m.f. E'_s obtained by this procedure is measured.
6. This procedure is repeated for a number of settings of the tone control, if any, and a number of frequencies of the signal, adequately covering the frequency range of the passive element, up to half the upper limiting frequency.

Note. — This test is of significance:

- as concerns setting of the volume control (attenuation) in the “reference” position, only if the passive networks include non-linear elements, as inductors or transformers with magnetic cores;
- as concerns other settings of the volume control (attenuation), only if non-linear elements are included between the input and the attenuating network of the volume control, or if the ultimate attenuation of the volume control is rather low.

Otherwise, the temperature limited input voltage has to be considered.

9.2 *Temperature limited input voltage*

9.2.1 *Characteristic to be specified*

The maximum r.m.s. input voltage which can be applied continuously at a specified pair of input terminals for any settings of the controls, the output terminals being terminated with the rated load impedance, at an appropriate ambient temperature, without exceeding the maximum permissible temperature in any component.

Note. — For ambient temperatures, see IEC Publication 68, Basic Environmental Testing Procedures.

9.2.2 *Method of measurement*

A provisional test shall be made to determine those components which are liable to reach the limiting temperature. Appropriate thermometers are mounted on the components selected according to this provisional test.

The measurement is made according to the following procedure:

1. The passive element, mounted in the specified position, is brought under rated conditions.
2. The source e.m.f. is increased in steps, waiting after each step until the thermometer readings have become practically constant. This procedure is maintained until one of the components reaches its limiting temperature. Then the input voltage U_1 is measured.
3. The measurement is repeated for different settings of the controls if any, in order to find the conditions for which the lowest value of U_1 is obtained.
4. This value of U_1 is assumed to be the temperature limited input voltage.

10. **Attenuation**

10.1 *Rated matched insertion loss*

10.1.1 *Characteristic to be specified*

The ratio, expressed in decibels, of the power available from the source to the output power for the passive element under normal working conditions. It is to be specified by the manufacturer.